PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-340497
(43)Date of publication of application : 02.12.2003

(51)Int.Cl. C02F 11/12
B01D 61/14
B01D 61/22

(21)Application number : 2002-148562
(22)Date of filing : 23.05.2002

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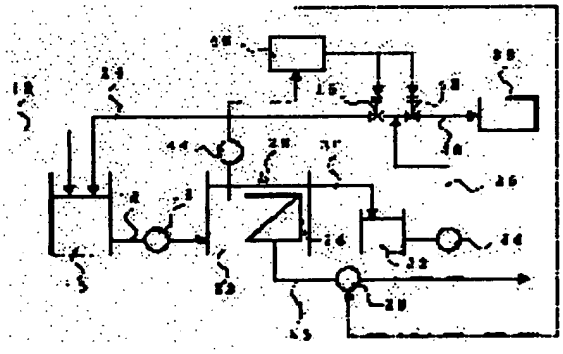
(54) METHOD FOR OPERATING MEMBRANE SEPARATION APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To approach the concentration of sludge in concentrated sludge discharged from a membrane separation apparatus to a desired value by stably keeping the load on the membrane separation apparatus.
SOLUTION: In a method for operating the membrane separation apparatus for separating the sludge supplied from a sludge supply vessel 10 into filtrate and the concentrated sludge by introducing the sludge into the membrane separation apparatus 20, one of operations consisting of a discharge operation to discharge the whole quantity of the concentrated sludge from the apparatus, a circulation operation to return the whole quantity of the concentrated sludge to the sludge supply vessel 10 and a pushing-out operation to discharge the concentrated sludge from the apparatus to the quantity corresponding to that of the supplied sludge supplied while stopping the membrane separation is automatically switched to other operation by a controller 46 correspondingly to the concentration of the sludge in the concentrated sludge which is detected by a sludge densitometer 44.



LEGAL STATUS

[Date of request for examination]	10.09.2004
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the operating method of the membrane separation device which is applied to the operating method of a membrane separation device, especially carries out membrane-separation processing of the sludge, and is divided into transparency liquid and concentration sludge.
[0002]
[Description of the Prior Art] In the field of waste water treatment or water purification processing, carrying out membrane-separation processing of the sludge generated by the biology target or physicochemical processing, and separating into transparency liquid and concentration sludge is performed. The immersing [in the separation tub which filled concentration sludge / the membrane module]-as membrane separation device for concentration thing is known. Generally in this immersion-type membrane separation device, operation which holds uniformly the flow rate of the transparency liquid attracted from a membrane module is performed, supplying the original sludge of a quantum to a separation tub continuously. It was operation which becomes fixed [the amount of the concentration sludge overflowed and discharged] as difference of original sludge and transparency liquid from a separation tub. The sludge concentration of concentration sludge becomes settled according to the concentration rate which is the ratio of the amount of original sludge, and the amount of concentration sludge. Therefore, in operation with the above fixed concentration rates, when the sludge concentration of original sludge is changed, the sludge concentration of concentration sludge is also changed proportionally.
[0003]
[Problem(s) to be Solved by the Invention] Although stable processing is possible from a quantitative viewpoint, when the sludge concentration of original sludge becomes high according to a certain cause according to the above-mentioned operating method, the sludge concentration of concentration sludge also becomes high, the blinding of a filtration membrane etc. is induced, and the fault on the operation of a membrane separation device is caused. Moreover, although concentration sludge received processing of dehydration, solar drying, incineration, etc. as latter-part processing, when the sludge concentration of concentration sludge was changed, the load of latter-part processing and operation became unstable, and there was a trouble of reducing the processing engine performance and effectiveness.
[0004] In order to solve such a trouble, the sludge concentration of concentration sludge is measured and it is possible to carry out feedback control of the flow rate of original sludge or transparency liquid so that the sludge concentration of concentration sludge may serve as desired value based on the measurement result. However, when fluctuation of the sludge concentration of original sludge is large, the load of a membrane separation device will also be followed in footsteps and changed, and such an approach causes the instability of operation, while the equipment configuration for realizing feedback control is complicated and becomes expensive. Without improving the trouble of the above-mentioned conventional technique and performing feedback control complicated even when fluctuation of the sludge concentration of original sludge is large, the load of a membrane separation device is maintained to stability, and the purpose of this invention is to offer the operating method of a membrane separation device which can bring the sludge concentration of the concentration sludge finally discharged out of a system close to desired value.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the operating method of

the membrane separation device concerning this invention Discharge operation which is the operating method of the membrane separation device which carries out membrane-separation processing of the supply sludge from a sludge supply tub, and is divided into transparency liquid and concentration sludge, and discharges the whole quantity of the concentration sludge discharged from a membrane separation device out of equipment, performing membrane-separation processing, Circulation operation which returns the whole quantity of the concentration sludge discharged from the aforementioned membrane separation device to said sludge supply tub, performing membrane-separation processing, It is characterized by changing automatically one of operations with extrusion operation which discharges the concentration sludge of the amount equivalent to the supply sludge supplied suspending membrane-separation processing out of equipment according to the sludge concentration of concentration sludge.

[0006] In the configuration of the above [the operating method of the membrane separation device concerning this invention] the sludge concentration of said concentration sludge Moreover, a lower limit, Classify into the three-stage of a mean value and a upper limit, and as a result of said discharge operation, when the sludge concentration of said concentration sludge descends and a lower limit is reached, it changes to said circulation operation. When the sludge concentration of said concentration sludge rises and a mean value is reached as a result of this circulation operation, it changes to said discharge operation. As a result of said discharge operation, when it changes to extrusion operation when the sludge concentration of concentration sludge reaches a upper limit, and the sludge concentration of said concentration sludge descends as a result of this extrusion operation and said mean value is reached, it is characterized by changing to said discharge operation. In the configuration of the above [the operating method of the membrane separation device concerning this invention] the sludge concentration of said concentration sludge Moreover, a lower limit, Classify into two steps of a upper limit, and as a result of said discharge operation, when the sludge concentration of said concentration sludge descends and a lower limit is reached, after carrying out predetermined time activation of said circulation operation, it changes to said discharge operation. As a result of said discharge operation, when the sludge concentration of said concentration sludge rises and a upper limit is reached, after carrying out predetermined time activation of said extrusion operation, it is characterized by changing to said discharge operation. In addition, in this invention, "when in agreement [the value is approached, and] with the value", "he shall understand" the vocabulary "the time when reaching a lower limit (a mean value, upper limit)" to "all when exceeding the value". ["the time of reaching"]

[0007] Moreover, in the configuration of the above [the operating method of the membrane separation device concerning this invention], it is characterized by said membrane separation device possessing the separation tub, the membrane module immersed in the concentration sludge in this separation tub, and a discharge means of concentration sludge to hold the oil level of concentration sludge uniformly.

[0008]

[Embodiment of the Invention] Drawing 1 is an equipment schematic diagram for enforcing the operating method of the membrane separation device concerning this invention. In drawing 1 , the original sludge which is a concentration object flows into the sludge supply tub 10 from a duct 12. Moreover, concentration sludge may be returned to this sludge supply tub 10 so that it may mention later from a duct 14. The sludge supply tub 10 is connected with a membrane separation device 20 by the duct 16, and the sludge in the sludge supply tub 10 is supplied to a membrane separation device 20 by the feed pump 18 prepared in the middle of the duct 16. In this invention, the sludge supplied to a membrane separation device 20 from such a sludge supply tub 10 is defined as supply sludge, and it distinguishes from said Hara sludge. A membrane separation device 20 mainly consists of a separation tub 22 and a membrane module 24 immersed in the concentration sludge in this separation tub 22. A duct 26 is connected to secondary [of a membrane module 24], and with the suction pump 28 prepared in this duct 26, the transparency liquid which penetrated the filtration membrane of a membrane module 24 is extracted from a duct 26, and is discharged out of equipment. Moreover, as for the concentration sludge in the separation tub 22 condensed by membrane separation, an overflowed part is discharged from a duct 30, the oil level being held uniformly.

[0009] The micro filter or ultrafiltration membrane formed with the organic material or the ceramic ingredient as film material of a membrane module 24 is used. The membrane module of a rotation flat film type it was made for the hollow fiber of an immersion type and a flat film to make rotate a disc-like flat film desirable especially as a form of a membrane module 24 is convenient to concentration of sludge. However, the membrane separation device concerning this invention is applicable also to the thing using the membrane module of not only a thing but a

juxtaductal type using an above-mentioned immersion-type membrane module.
[0010] After the concentration sludge discharged from the duct 30 goes via ****** 32, it is sent out from a duct 36 with an eductor pump 34 to either said sludge supply tub 10 or the sludge tank 38. That is, the duct 36 has branched to the duct 14 for circulation, and the duct 40 for discharge, a selector valve 15 is formed in a duct 14, and the selector valve 42 is formed in the duct 40. By operating closing motion of this selector valve 15 and a selector valve 42, the concentration sludge from a duct 36 is returned to the sludge supply tub 10 through a duct 14, or is discharged by the sludge tank 38 through a duct 42. Actuation of a selector valve 15 and a selector valve 42 is controlled by the controller 46 which incorporates a sludge densitometer's 44 detecting signal arranged in said separation tub 22. Moreover, this controller 46 is equipped with the function which outputs the signal which changes operation and a halt of a suction pump 28 according to a sludge densitometer's 44 detecting signal. In addition, the oil level of the concentration sludge in the separation tub 22 is not restricted to the approach by the overflow described above as a discharge means of the concentration sludge held uniformly. For example, a duct 30 and an eductor pump 34 are connected directly, without minding ****** 32, and you may make it control the amount of drawing of the concentration sludge by the eductor pump 34 so that the indicated value of the level gage established in the separation tub 22 becomes fixed.
[0011] In the above-mentioned configuration, it flows into the sludge supply tub 10 continuously [original sludge] or intermittently from a duct 12. Moreover, at the time of circulation operation mentioned later, concentration sludge flows into the sludge supply tub 10 from a duct 14. Thus, when concentration sludge flows in the sludge supply tub 10, the supply sludge adjusted to concentration with sludge concentration comparatively higher than original sludge is supplied to a membrane separation device 20. Usually, in a membrane separation device 20, operation which holds uniformly the flow rate of the transparency liquid attracted from the flow rate and membrane module 24 of supply sludge which are supplied is carried out. Consequently, the flow rate of the concentration sludge which overflows the separation tub 22 and is discharged is also held uniformly. In addition, the sludge concentration of the concentration sludge in the separation tub 22 is detected by the sludge densitometer 44 at intervals of suitable continuous or control, and the detecting signal is transmitted to a controller 46.
[0012] The operation mode of the membrane separation device 20 concerned is classified into three kinds, discharge operation, circulation operation, and extrusion operation. Discharge operation is operation when target within the limits has the normal sludge concentration of concentration sludge, and it discharges the whole quantity of the concentration sludge discharged from a membrane separation device 20 out of equipment, performing membrane-separation processing. The concentration sludge which makes a selector valve 15 close and is discharged from a membrane separation device 20 by making a selector valve 42 open is discharged to the sludge tank 38, holding uniformly the flow rate of the transparency liquid which works and specifically attracts a feed pump 18 and a suction pump 28 from the flow rate and membrane module 24 of supply sludge, and performing membrane-separation processing. Circulation operation is operation when comparatively low concentration [the sludge concentration of concentration sludge], and it returns the whole quantity of the concentration sludge discharged from a membrane separation device 20 to the sludge supply tub 10, performing membrane-separation processing. The concentration sludge which makes a selector valve 15 open and is discharged from a membrane separation device 20 by making a selector valve 42 close is returned to the sludge supply tub 10, holding uniformly the flow rate of the transparency liquid which works and specifically attracts a feed pump 18 and a suction pump 28 from the flow rate and membrane module 24 of supply sludge, and performing membrane-separation processing. If this circulation operation is performed, in the sludge supply tub 10, original sludge and concentration sludge will be mixed and the concentration sludge of supply sludge will go up. Consequently, the sludge concentration of concentration sludge also rises. Extrusion operation is operation when comparatively high concentration [the sludge concentration of concentration sludge], and discharges the whole quantity of the concentration sludge of the amount equivalent to the supply sludge supplied suspending membrane-separation processing out of equipment. concrete -- the flow rate of the supply sludge from a feed pump 18 -- while holding uniformly, a suction pump 28 is suspended, membrane-separation processing is suspended, and the concentration sludge of the amount which makes a selector valve 15 close and is equivalent to supply sludge by making a selector valve 42 open is discharged to the sludge tank 38. If this extrusion operation is performed, the concentration sludge in the separation tub 22 will be serially permuted by supply sludge with low sludge concentration. Consequently, the sludge concentration of concentration sludge descends comparatively quickly.
[0013] The change of the three above-mentioned kinds of operation modes is performed by the change signal of

operation of the change signal of said selector valve 15 and a selector valve 42 and suction pump 28 by the controller 46 according to the detecting signal from a sludge densitometer 44, and a halt. Drawing 2 is a flow chart which shows the control procedure. When it starts from discharge operation, more than a lower limit, if it is the normal values of under a upper limit, and discharge operation will be continued (S100) and it will become under a lower limit, it will change to circulation operation (S110), and if the sludge concentration of concentration sludge becomes more than a upper limit, it will change to extrusion operation (S120). If with [even if it carries out circulation operation / sludge concentration] a mean value [under] circulation operation is continued (S130) and it becomes beyond a mean value, it will change to discharge operation (S140). Moreover, if extrusion operation is continued (S150) and it becomes below a mean value when sludge concentration exceeds a mean value, even if it carries out extrusion operation, it will change to discharge operation (S160). By the change of such operation mode, even when the sludge concentration of original sludge is changed sharply, the sludge concentration of the concentration sludge discharged out of equipment from a membrane separation device 20 can be mostly maintained to target within the limits of under a upper limit more than a lower limit. In addition, although the above-mentioned example is the case where a mean value is made into one point, this invention is not restricted to this. For example, mean value ** and mean value ** are set up as a mean value, and you may make it use mean value ** as a change control point of extrusion operation and discharge operation, using mean value ** as a change control point of circulation operation and discharge operation.

[0014] Drawing 3 models and shows the aging situation of the sludge concentration of original sludge and concentration sludge, when change control of the above-mentioned operation mode is performed. (b) shows aging of the sludge concentration of original sludge, for example, assumes that the sludge concentration of original sludge was changed in the time zone T1, and was changed to 1.5% or more in the time zone T2 0.5% or less to 1.0% of standard concentration. (b) is the case where aging of the sludge concentration of the concentration sludge accompanying concentration fluctuation of original sludge was shown, for example, made 4.0% of standard concentration into the mean value, set up the lower limit 3.8%, set up the upper limit to 4.2%, and control is performed. Since the sludge supply tub 10 and the separation tub 22 have a suitable capacity and sludge carries out fixed time amount stagnation, the sludge concentration of concentration sludge is overdue to concentration fluctuation of original sludge, and where it absorbed concentration fluctuation to some extent and it is equalized, it is changed. For this reason, even if it changes the sludge concentration of original sludge somewhat focusing on 1.0% of standard concentration, if discharge operation A is performed, the sludge concentration of concentration sludge will change to stability comparatively focusing on 4.0% of standard concentration. However, as shown in (b), the sludge concentration of concentration sludge will descend gradually and 0.5% or less of time zone T1 will reach 3.8% of ******** at last, if the sludge concentration of original sludge continues over long duration comparatively. Then, a controller 46 outputs the change signal with which a selector valve 15 is made open and it makes a selector valve 42 close according to the detecting signal from a sludge densitometer 44, and changes operation mode to the circulation operation B. As a result of this circulation operation B, the sludge concentration of concentration sludge rises gradually and reaches 4.0% of standard concentration which is a mean value. Then, a controller 46 outputs the change signal with which a selector valve 15 is made close and it makes a selector valve 42 open according to the detecting signal from a sludge densitometer 44, and returns operation mode to the discharge operation A. However, when 0.5% or less of time zone is continuing [the sludge concentration of original sludge], the sludge concentration of concentration sludge descends again by the discharge operation A. Therefore, such discharge operation A and the circulation operation B will be repeated by turns during the period which 0.5% or less of time zone T1 continues [the sludge concentration of original sludge].

[0015] On the other hand, as shown in (b), if 1.5% or more of time zone T2 continues over long duration comparatively, it will go up gradually, and, as for the sludge concentration of concentration sludge, the sludge concentration of original sludge reaches ******** to 4.2% at last. Then, a controller 46 changes operation mode from the discharge operation A to the extrusion operation C according to the detecting signal from a sludge densitometer 44. namely, -- while maintaining the condition of having made the selector valve 15 close and having made the selector valve 42 open -- the flow rate of the supply sludge from a feed pump 18 -- while holding uniformly, a suction pump 28 is suspended and membrane-separation processing is suspended. As a result of this extrusion operation C, the concentration sludge in the separation tub 22 is serially permuted by supply sludge with low sludge concentration, and the sludge concentration of concentration sludge descends quickly and reaches 4.0% of standard concentration which is a mean value. Then, a controller 46 re-works a suction pump 28 according to the

detecting signal from a sludge densitometer 44, and returns operation mode to the discharge operation A. However, when 1.5% or more of time zone is continuing [the sludge concentration of original sludge], the sludge concentration of concentration sludge rises again by the discharge operation A. Therefore, such discharge operation A and the extrusion operation C will be repeated by turns during the period which 1.5% or more of time zone T2 continues [the sludge concentration of original sludge].

[0016] Even when changing the sludge concentration of original sludge sharply to 1.0% of standard concentration in 0.5% or less and 1.5% or more of range as above-mentioned according to the gestalt of this operation, sludge concentration of the concentration sludge discharged out of equipment can always be made into the stable value of about 4% of averages (4.2% of upper limits, 3.8% of minimums). For this reason, complicated control of original sludge, the control of flow of transparency liquid, etc. is not needed to fluctuation of sludge concentration, but concentration actuation of stable sludge can be carried out.

[0017] Drawing 4 is a flow chart which shows other control procedures. It starts from discharge operation, and more than a lower limit, if discharge operation will be continued if it is the normal values of under a upper limit (S200), and it becomes under a lower limit, it will change to circulation operation (S210), and if the sludge concentration of concentration sludge becomes more than a upper limit, it will change to extrusion operation (S220). In circulation operation, if operation is continued (S230) and it goes through predetermined setup-time T3 until predetermined setup-time T3 passes, it will change to discharge operation (S240). Moreover, in extrusion operation, if operation is continued (S250) and it goes through predetermined setup-time T four until predetermined setup-time T four passes, it will change to discharge operation (S260). According to this control approach, since the operation time of circulation operation and extrusion operation is set up by the timer, the simplification of control can be attained compared with the control based on the mean value (standard concentration) shown in drawing 2 . In addition, a difference is in the responsibility over the sludge concentration of concentration sludge by circulation operation and extrusion operation. Therefore, the thing of a lower limit and a upper limit which the sludge concentration of the concentration sludge at the time of lengthening setup-time T3 in slow circulation operation, a response shortening setup-time T four in sensitive extrusion operation, and a response changing each operation to discharge operation sets up so that middle may come mostly is desirable.

[0018]

[Effect of the Invention] According to the concentration approach of the sludge applied to this invention as above-mentioned, even when fluctuation of the sludge concentration of original sludge is large, without performing complicated feedback control, the load of a membrane separation device can be maintained to stability, and the sludge concentration of the concentration sludge finally discharged out of a system can be brought close to fixed desired value.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The equipment schematic diagram for enforcing the operating method of the membrane separation device concerning this invention.
[Drawing 2] The flow chart which shows the operation gestalt of the operating method concerning this invention.
[Drawing 3] The explanatory view which illustrated aging of sludge concentration, such as concentration sludge, when [concerning this invention] operating-method activation was carried out.
[Drawing 4] The flow chart which shows other operation gestalten of the operating method concerning this invention.
[Description of Notations]
10 .... Sludge supply tub
15 .... Selector valve
18 .... (supply sludge) Feed pump
20 .... Membrane separation device
22 .... Separation tub
24 .... Membrane module
28 .... (transparency liquid) Suction pump
32 .... ******
34 .... (concentration sludge) Eductor pump
38 .... Sludge tank
42 .... Selector valve
42 .... Sludge densitometer
46 .... Control

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CLAIMS

[Claim(s)]
[Claim 1] Discharge operation which is the operating method of the membrane separation device which carries out membrane-separation processing of the supply sludge from a sludge supply tub, and is divided into transparency liquid and concentration sludge, and discharges the whole quantity of the concentration sludge discharged from a membrane separation device out of equipment, performing membrane-separation processing, Circulation operation which returns the whole quantity of the concentration sludge discharged from the aforementioned membrane separation device to said sludge supply tub, performing membrane-separation processing, The operating method of the membrane separation device characterized by changing automatically one of operations with extrusion operation which discharges the concentration sludge of the amount equivalent to the supply sludge supplied suspending membrane-separation processing out of equipment according to the sludge concentration of concentration sludge.
[Claim 2] The sludge concentration of said concentration sludge is classified into the three-stage of a lower limit, a mean value, and a upper limit. When the sludge concentration of said concentration sludge descends and a lower limit is reached as a result of said discharge operation, it changes to said circulation operation. When the sludge concentration of said concentration sludge rises and a mean value is reached as a result of this circulation operation, it changes to said discharge operation. The operating method of the membrane separation device according to claim 1 characterized by changing to extrusion operation as a result of said discharge operation when the sludge concentration of concentration sludge reaches a upper limit, and changing to said discharge operation when the sludge concentration of said concentration sludge descends and said mean value is reached as a result of this extrusion operation.
[Claim 3] The sludge concentration of said concentration sludge is classified into two steps, a lower limit and a upper limit. The result of said discharge operation, When the sludge concentration of said concentration sludge descends and a lower limit is reached, after carrying out predetermined time activation of said circulation operation, it changes to said discharge operation. The operating method of the membrane separation device according to claim 1 characterized by changing to said discharge operation after carrying out predetermined time activation of said extrusion operation, when the sludge concentration of said concentration sludge rises and a upper limit is reached as a result of said discharge operation.
[Claim 4] Said membrane separation device is the operating method of the membrane separation device according to claim 1 to 3 characterized by providing the separation tub, the membrane module immersed in the concentration sludge in this separation tub, and a discharge means of concentration sludge to hold the oil level of concentration sludge uniformly.

[Translation done.]

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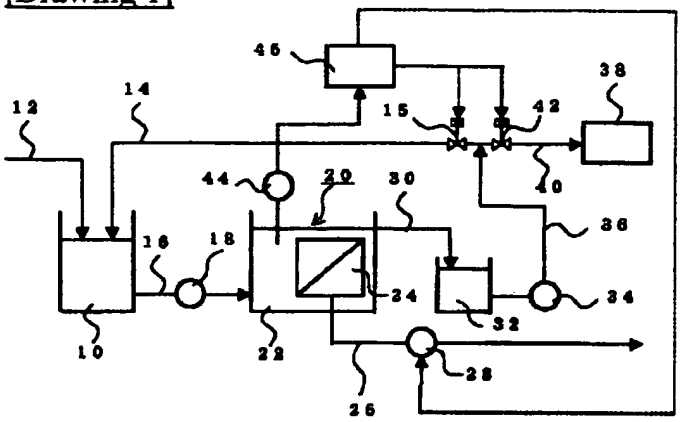
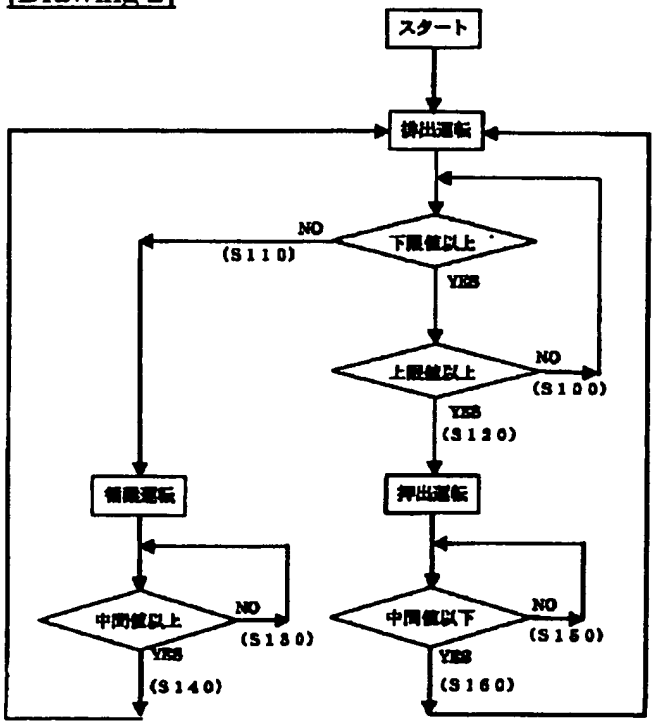
DRAWINGS

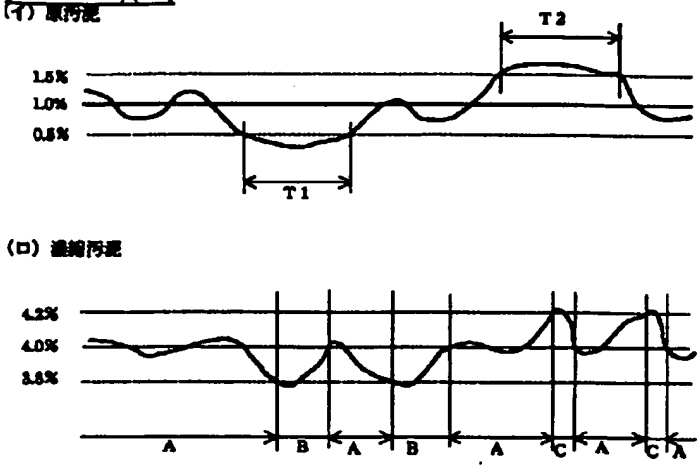
[Drawing 1]



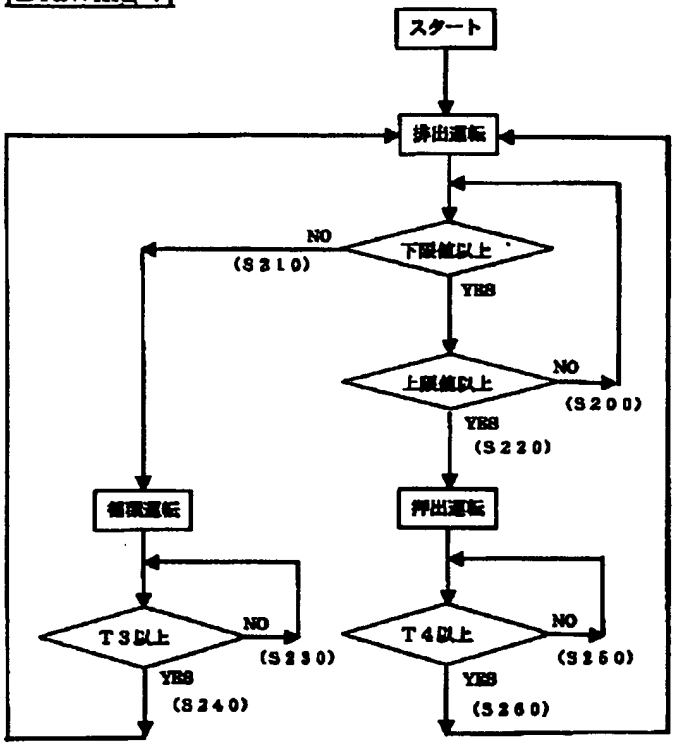
[Drawing 2]



[Drawing 3]



[Drawing 4]



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(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2003－340497
（P2003－340497A）
(43)公開日　平成15年12月2日(2003.12.2)

(51)Int.Cl.'		識別記号	FI			テーマコード'(参考)
C02F	11/12		C02F	11/12	C	4D006
B01D	61/14	500	B01D	61/14	500	4D059
	61/22			61/22		

審査請求　未請求　請求項の数4　ＯＬ　（全 6 頁）

(21)出願番号　特願2002－143562(P2002－143562)

(22)出願日　平成14年５月23日(2002.5.23)

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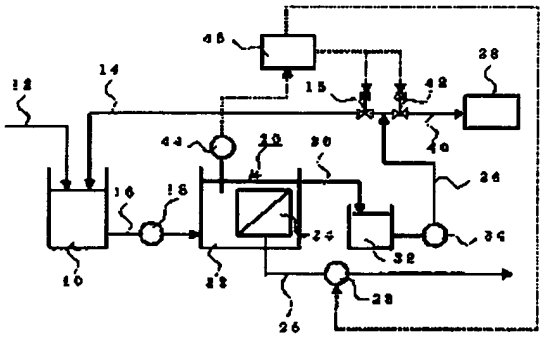
最終頁に続く

(54)【発明の名称】　膜分離装置の運転方法

(57)【要約】
【課題】　膜分能装置の負荷を安定に維持し、装置外に排出する濃縮汚泥の汚泥濃度を目標値に近づける。
【解決手段】　汚泥供給槽１０からの供給汚泥を膜分離装置２０に導き膜分離処理して透過液と濃縮汚泥とに分離する膜分離装置の運転方法であって．膜分離装置２０から排出される濃縮汚泥の全量を装置外に排出する排出運転と、濃縮汚泥の全量を汚泥供給槽１０に返送する循環運転と、膜分能処理を停止しつつ供給される供給汚泥に相当する量の濃縮汚泥を装置外に排出する押出運転との．いずれかの運転を汚泥濃度計４４で検出される濃縮汚泥の汚泥濃度に応じて制御器４６により自動的に切り替える。



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【特許請求の範囲】

【請求項１】汚泥供給槽からの供給汚泥を膜分離処理して透過液と濃縮汚泥とに分離する膜分離装置の運転方法であって、膜分離処理を行いつつ膜分離装置から排出される濃縮汚泥の全量を装置外に排出する排出運転と、膜分離処理を行いつつ前記膜分離装置から排出される濃縮汚泥の全量を前記汚泥供給槽に返送する循環運転と、膜分離処理を停止しつつ供給される供給汚泥に相当する量の濃縮汚泥を装置外に排出する押出運転との、いずれかの運転を濃縮汚泥の汚泥濃度に応じて自動的に切り替えることを特徴とする膜分離装置の運転方法。

【請求項２】前記濃縮汚泥の汚泥濃度を下限値．中間値．上限値の３段階に区分し、前記排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転に切り替え．この循環運転の結果．前記濃縮汚泥の汚泥濃度が上昇して中間値に達した時には前記排出運転に切り替え、前記排出運転の結果、濃縮汚泥の汚泥濃度が上限値に達した時には押出運転に切り替え、この押出運転の結果、前記濃縮汚泥の汚泥濃度が下降して前記中間値に達した時には前記排出運転に切り替えることを特徴とする請求項１に記載の膜分離装置の運転方法。

【請求項３】前記濃縮汚泥の汚泥濃度を下限値．上限値の２段階に区分し、前記排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転を所定時間実行した後に前記排出運転に切り替え、前記排出運転の結果、前記濃縮汚泥の汚泥濃度が上昇して上限値に達した時には前記押出運転を所定時間実行した後に前記排出運転に切り替えることを特徴とする請求項１に記載の膜分離装置の運転方法。

【請求項４】前記膜分離装置は分離槽と、この分離槽内の濃縮汚泥に浸漬された膜モジュールと、濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段とを具備していることを特徴とする請求項１乃至請求項３のいずれかに記載の膜分離装置の運転方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は膜分離装置の運転方法に係り、特に汚泥を膜分離処理して透過液と濃縮汚泥とに分離する膜分離装置の運転方法に関する。

【０００２】

【従来の技術】廃水処理や浄水処理の分野では．生物学的や物理化学的な処理によって発生した汚泥を膜分離処理して透過液と濃縮汚泥とに分離することが行われている。濃縮のための膜分離装置としては．濃縮汚泥を満たした分離槽内に膜モジュールを浸漬したものが知られている。この浸漬式の膜分離装置においては、定量の原汚泥を分離槽に連続的に供給しつつ．膜モジュールから吸引する透過液の流量を一定に保持する運転が一般的に行われている。分離槽からオーバーフローして排出される濃縮汚泥の量も原汚泥と透過液の差分として一定となる運転であった。濃縮汚泥の汚泥濃度は原汚泥量と濃縮汚泥量との比である濃縮倍率によって定まる。したがって．上記のような濃縮倍率が一定の運転では原汚泥の汚泥濃度が変動した場合には濃縮汚泥の汚泥濃度も比例して変動する。

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【０００３】

【発明が解決しようとする課題】上述の運転方法によれば量的な観点からは安定な処理が可能であるが．何らかの原因によって原汚泥の汚泥濃度が高くなった時には、濃縮汚泥の汚泥濃度も高くなり、透過膜の目詰まりなどを誘発して膜分離装置の運転操作上の不具合を招く。また．濃縮汚泥は後段処理として脱水．天日乾燥．焼却などの処理を受けるが、濃縮汚泥の汚泥濃度が変動すると後段処理の負荷や運転が不安定となり．処理性能や効率を低下させるという問題点があった。

【０００４】このような問題点を解決するために．濃縮汚泥の汚泥濃度を計測し．その計測結果に基づいて濃縮汚泥の汚泥濃度が目標値となるように原汚泥や透過液の流量をフィードバック制御することが考えられる。しかしながら、このような方法はフィードバック制御を実現するための装置構成が複雑で高価になるとともに．原汚泥の汚泥濃度の変動が大きい場合には膜分離装置の負荷も追随して変動することになり、運転の不安定を招く。本発明の目的は．上記従来技術の問題点を改善し．原汚泥の汚泥濃度の変動が大きい場合でも．複雑なフィードバック制御を行うことなく膜分離装置の負荷を安定に維持し．かつ、最終的に系外に排出する濃縮汚泥の汚泥濃度を目標値に近づけることができる膜分離装置の運転方法を提供することにある。

【０００５】

【課題を解決するための手段】上記の課題を解決するために．本発明に係る膜分離装置の運転方法は、汚泥供給槽からの供給汚泥を膜分離処理して透過液と濃縮汚泥とに分離する膜分離装置の運転方法であって、膜分離処理を行いつつ膜分離装置から排出される濃縮汚泥の全量を装置外に排出する排出運転と、膜分離処理を行いつつ前記膜分離装置から排出される濃縮汚泥の全量を前記汚泥供給槽に返送する循環運転と、膜分離処理を停止しつつ供給される供給汚泥に相当する量の濃縮汚泥を装置外に排出する押出運転との、いずれかの運転を濃縮汚泥の汚泥濃度に応じて自動的に切り替えることを特徴とする。

【０００６】また、本発明に係る膜分離装置の運転方法は上記の構成において、前記濃縮汚泥の汚泥濃度を下限値．中間値．上限値の３段階に区分し．前記排出運転の結果．前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転に切り替え、この循環運転の結果．前記濃縮汚泥の汚泥濃度が上昇して中間値に達した時には前記排出運転に切り替え、前記排出運転の結果、濃縮汚泥の汚泥濃度が上限値に達した時には押出運転に

切り替え、この押出運転の結果、前記濃縮汚泥の汚泥濃度が下降して前記中間値に達した時には前記排出運転に切り替えることを特徴とする。また、本発明に係る膜分離装置の運転方法は上記の構成において、前記濃縮汚泥の汚泥濃度を下限値、上限値の２段階に区分し、前記排出運転の結果、前記濃縮汚泥の汚泥濃度が下降して下限値に達した時には前記循環運転を所定時間実行した後に前記排出運転に切り替え、前記排出運転の結果、前記濃縮汚泥の汚泥濃度が上昇して上限値に達した時には前記押出運転を所定時間実行した後に前記排出運転に切り替えることを特徴とする。なお、本発明において「下限値（中間値、上限値）に達した時」の「達した時」という用語は、「その値に接近した時」「その値に一致した時」「その値を超えた時」のいずれにも理解し得るものとする。

【０００７】また、本発明に係る膜分離装置の運転方法は上記の構成において、前記膜分離装置は分離槽と、この分離槽内の濃縮汚泥に浸漬された膜モジュールと、濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段とを具備していることを特徴とする。

【０００８】

【発明の実施の形態】図１は本発明に係る膜分離装置の運転方法を実施するための装置系統図である。図１において汚泥供給槽１０には管路１２から濃縮対象物である原汚泥が流入する。また、この汚泥供給槽１０には管路１４から後述するように濃縮汚泥が返送される場合がある。汚泥供給槽１０は管路１６によって膜分離装置２０と接続され、汚泥供給槽１０内の汚泥は管路１６の途中に設けた供給ポンプ１８によって、膜分離装置２０に供給される。本発明においては、このような汚泥供給槽１０から膜分離装置２０に供給される汚泥を供給汚泥と定義し、前記原汚泥と区別する。膜分離装置２０は主として分離槽２２と、この分離槽２２内の濃縮汚泥に浸漬された膜モジュール２４とからなる。膜モジュール２４の二次側には管路２６が接続され、この管路２６に設けた吸引ポンプ２８によって、膜モジュール２４の濾過膜を透過した透過液が管路２６から抜き出され、装置外に排出される。また、膜分離によって濃縮された分離槽２２内の濃縮汚泥は、その液面が一定に保持されつつ、オーバーフロー分が管路３０から排出される。

【０００９】膜モジュール２４の膜材としては有機材料又はセラミック材料で形成された精密濾過膜又は限外濾過膜が用いられる。膜モジュール２４の型式としては浸漬式の中空糸膜、平膜が好ましく、特に円盤状の平膜を回転させるようにした回転平膜式の膜モジュールが汚泥の濃縮用に好都合である。しかしながら、本発明に係る膜分離装置は上記の浸漬式の膜モジュールを用いたものに限らず、例えば管型の膜モジュールを用いたものにも適用可能である。

【００１０】管路３０から排出された濃縮汚泥は汚泥溜３２を経由したのち、排出ポンプ３４によって管路３６から前記汚泥供給槽１０又は汚泥貯槽３８のいずれか一方に送出される。すなわち、管路３６は循環用の管路１４と排出用の管路４０とに分岐しており、管路１４には切替弁１５が、管路４０には切替弁４２が設けられている。この切替弁１５と切替弁４２の開閉を操作することによって、管路３６からの濃縮汚泥は管路１４を介して汚泥供給槽１０に返送されるか、又は管路４２を介して汚泥貯槽３８に排出される。切替弁１５と切替弁４２の操作は前記分離槽２２に配設した汚泥濃度計４４の検出信号を取り込む制御器４６によって制御される。また、この制御器４６は汚泥濃度計４４の検出信号に応じて、吸引ポンプ２８の稼動と停止を切り替える信号を出力する機能を備えている。なお、分離槽２２内の濃縮汚泥の液面を一定に保持する濃縮汚泥の排出手段としては前記したオーバーフローによる方法に限らない。例えば管路３０と排出ポンプ３４とを汚泥溜３２を介さずに直接に接続し、分離槽２２内に設けた液面計の指示値が一定となるように排出ポンプ３４による濃縮汚泥の引き抜き量を制御するようにしてもよい。

【００１１】上記の構成において、汚泥供給槽１０には管路１２から原汚泥が連続的又は間欠的に流入する。また、後述する循環運転時には汚泥供給槽１０に管路１４から濃縮汚泥が流入する。このように濃縮汚泥が汚泥供給槽１０内に流入する場合には、原汚泥よりは汚泥濃度が比較的高い濃度に調整された供給汚泥が膜分離装置２０に供給される。通常は膜分離装置２０では供給される供給汚泥の流量及び膜モジュール２４から吸引する透過液の流量を一定に保持する運転をする。その結果、分離槽２２をオーバーフローして排出される濃縮汚泥の流量も一定に保持される。なお、分離槽２２内の濃縮汚泥の汚泥濃度は汚泥濃度計４４によって連続的に又は適当な制御間隔で検出され、制御器４６にその検出信号が送信される。

【００１２】当該膜分離装置２０の運転モードは排出運転、循環運転、押出運転の３種類に区分される。排出運転は濃縮汚泥の汚泥濃度が目標範囲内の正常な時の運転であり、膜分離処理を行いつつ膜分離装置２０から排出される濃縮汚泥の全量を装置外に排出する。具体的には供給ポンプ１８と吸引ポンプ２８を稼動し、供給汚泥の流量及び膜モジュール２４から吸引する透過液の流量を一定に保持して膜分離処理を行いつつ、切替弁１５を閉、切替弁４２を開として膜分離装置２０から排出される濃縮汚泥を汚泥貯槽３８に排出する。循環運転は濃縮汚泥の汚泥濃度が比較的低濃度な時の運転であり、膜分離処理を行いつつ膜分離装置２０から排出される濃縮汚泥の全量を汚泥供給槽１０に返送する。具体的には供給ポンプ１８と吸引ポンプ２８を稼動し、供給汚泥の流量及び膜モジュール２４から吸引する透過液の流量を一定に保持して膜分離処理を行いつつ、切替弁１５を開、切

替弁４２を開として膜分離装置２０から排出される濃縮汚泥を汚泥供給槽１０に返送する。この循環運転を行うと汚泥供給槽１０では原汚泥と濃縮汚泥が混合し、供給汚泥の濃縮汚泥が上昇する。その結果、濃縮汚泥の汚泥濃度も上昇する。押出運転は濃縮汚泥の汚泥濃度が比較的高濃度な時の運転であり、膜分離処理を停止しつつ供給される供給汚泥に相当する量の濃縮汚泥の全量を装置外に排出する。具体的には供給ポンプ１８からの供給汚泥の流量一定に保持するとともに、吸引ポンプ２８を停止して膜分離処理を停止し、切替弁１５を開、切替弁４２を開として供給汚泥に相当する量の濃縮汚泥を汚泥貯槽３８に排出する。この押出運転を行うと分離槽２２内の濃縮汚泥が逐次、汚泥濃度が低い供給汚泥と置換される。その結果、濃縮汚泥の汚泥濃度が比較的急速に下降する。

【００１３】上記３種類の運転モードの切り替えは汚泥濃度計４４からの検出信号に応じた制御器４６による前記切替弁１５と切替弁４２の切り替え信号及び吸引ポンプ２８の稼動と停止の切り替え信号によって実行される。図２はその制御手順を示すフローチャートである。排出運転からスタートした場合、濃縮汚泥の汚泥濃度が下限値以上、上限値未満の正常値であれば排出運転を継続し（Ｓ１００）、下限値未満になると循環運転に切り替え（Ｓ１１０）、上限値以上になると押出運転に切り替える（Ｓ１２０）。循環運転をしても汚泥濃度が中間値未満であれば循環運転を継続し（Ｓ１３０）、中間値以上になると排出運転に切り替える（Ｓ１４０）。また、押出運転をしても汚泥濃度が中間値を超える時には押出運転を継続し（Ｓ１５０）、中間値以下になると排出運転に切り替える（Ｓ１６０）。このような運転モードの切り替えによって、原汚泥の汚泥濃度が大幅に変動した場合でも膜分離装置２０から装置外へ排出される濃縮汚泥の汚泥濃度を下限値以上、上限値未満の目標範囲内にほぼ維持することができる。なお、上記の例は中間値を１点とする場合であるが、本発明はこれに限らない。例えば中間値として中間値❶と中間値❷を設定し、循環運転と排出運転との切り替え制御点として中間値❶を用い、押出運転と排出運転との切り替え制御点として中間値❷を用いるようにしてもよい。

【００１４】図３は上記の運転モードの切り替え制御を実行した場合に、原汚泥と濃縮汚泥の汚泥濃度の経時変化状況をモデル化して示したものである。（イ）は原汚泥の汚泥濃度の経時変化を示し、例えば標準濃度１．０％に対して、時間帯Ｔ１では０．５％以下、時間帯Ｔ２では１．５％以上に原汚泥の汚泥濃度が変動したと仮定する。（ロ）は原汚泥の濃度変動に伴う濃縮汚泥の汚泥濃度の経時変化を示し、例えば標準濃度４．０％を中間値とし、下限値を３．８％、上限値を４．２％に設定して制御を実行した場合である。汚泥供給槽１０や分離槽２２は相応の容量を有しており、汚泥が一定時間滞留するので、濃縮汚泥の汚泥濃度は原汚泥の濃度変動に対して遅れて、かつ濃度変動をある程度吸収して平均化した状態で変動する。このため、原汚泥の汚泥濃度が標準濃度１．０％を中心に多少変動しても、排出運転Ａを実行すれば濃縮汚泥の汚泥濃度は標準濃度４．０％を中心に比較的安定に推移する。しかしながら、（イ）に示したように原汚泥の汚泥濃度が０．５％以下の時間帯Ｔ１が比較的長時間にわたって継続すると、濃縮汚泥の汚泥濃度は徐々に下降して、終には下限値の３．８％に達する。すると制御器４６は汚泥濃度計４４からの検出信号に応じて切替弁１５を開、切替弁４２を閉とする切り替え信号を出力して、運転モードを循環運転Ｂに切り替える。この循環運転Ｂの結果、濃縮汚泥の汚泥濃度が徐々に上昇し、中間値である標準濃度４．０％に達する。すると制御器４６は汚泥濃度計４４からの検出信号に応じて切替弁１５を閉、切替弁４２を開とする切り替え信号を出力して、運転モードを排出運転Ａに復帰させる。しかしながら、原汚泥の汚泥濃度が０．５％以下の時間帯が継続している場合には排出運転Ａにより、濃縮汚泥の汚泥濃度は再び下降する。したがって、原汚泥の汚泥濃度が０．５％以下の時間帯Ｔ１が継続する期間中はこのような排出運転Ａと循環運転Ｂが交互に繰り返されることになる。

【００１５】一方、（イ）に示したように原汚泥の汚泥濃度が１．５％以上の時間帯Ｔ２が比較的長時間にわたって継続すると、濃縮汚泥の汚泥濃度は徐々に上昇して、終には上限値を４．２％に達する。すると制御器４６は汚泥濃度計４４からの検出信号に応じて運転モードを排出運転Ａから押出運転Ｃに切り替える。すなわち、切替弁１５を閉、切替弁４２を開とした状態を維持しつつ、供給ポンプ１８からの供給汚泥の流量一定に保持するとともに、吸引ポンプ２８を停止して膜分離処理を停止する。この押出運転Ｃの結果、分離槽２２内の濃縮汚泥が逐次、汚泥濃度が低い供給汚泥と置換され、濃縮汚泥の汚泥濃度が急速に下降して中間値である標準濃度４．０％に達する。すると制御器４６は汚泥濃度計４４からの検出信号に応じて吸引ポンプ２８を再稼動し、運転モードを排出運転Ａに復帰させる。しかしながら、原汚泥の汚泥濃度が１．５％以上の時間帯が継続している場合には排出運転Ａにより、濃縮汚泥の汚泥濃度は再び上昇する。したがって、原汚泥の汚泥濃度が１．５％以上の時間帯Ｔ２が継続する期間中はこのような排出運転Ａと押出運転Ｃが交互に繰り返されることになる。

【００１６】上述のとおり、本実施の形態によれば原汚泥の汚泥濃度が標準濃度１．０％に対して、０．５％以下や１．５％以上の範囲で大きく変動する場合でも、装置外に排出する濃縮汚泥の汚泥濃度を常に平均約４％（上限４．２％、下限３．８％）の安定した値にすることができる。このため、汚泥濃度の変動に対して原汚泥や透過液の流量制御などの複雑な制御を必要とせず、安定した

汚泥の濃縮操作を実施できる。

【００１７】図４は他の制御手順を示すフローチャートである。排出運転からスタートし、濃縮汚泥の汚泥濃度が下限値以上．上限値未満の正常値であれば排出運転を継続し（Ｓ２００）、下限値未満になると循環運転に切り替え（Ｓ２１０）、上限値以上になると抑出運転に切り替える（Ｓ２２０）。循環運転では所定の設定時間Ｔ３が経過するまで運転を継続し（Ｓ２３０）、所定の設定時間Ｔ３を経過すると排出運転に切り替える（Ｓ２４０）。また、抑出運転では所定の設定時間Ｔ４が経過するまで運転を継続し（Ｓ２５０）、所定の設定時間Ｔ４を経過すると排出運転に切り替える（Ｓ２６０）。この制御方法によれば、循環運転と抑出運転の運転時間をタイマーによって設定するので図２に示した中間値（標準濃度）に基づく制御に比べて、制御の単純化を図ることができる。なお．循環運転と抑出運転とでは、濃縮汚泥の汚泥濃度に対する応答性に差がある。したがって、応答が緩慢な循環運転では設定時間Ｔ３を長めとし．応答が敏感な抑出運転では設定時間Ｔ４を短めとし．各運転を排出運転に切り替えた際の濃縮汚泥の汚泥濃度が下限値と上限値とのほぼ中間となるように設定することが好ましい。

【００１８】

【発明の効果】上述のとおり、本発明に係る汚泥の濃縮方法によれば．原汚泥の汚泥濃度の変動が大きい場合でも．複雑なフィードバック制御を行うことなく膜分離装＊置の負荷を安定に維持し．かつ、最終的に系外に排出する濃縮汚泥の汚泥濃度を一定の目標値に近づけることができる。

【図面の簡単な説明】

【図１】本発明に係る膜分離装置の運転方法を実施するための装置系統図。

【図２】本発明に係る運転方法の実施形態を示すフローチャート。

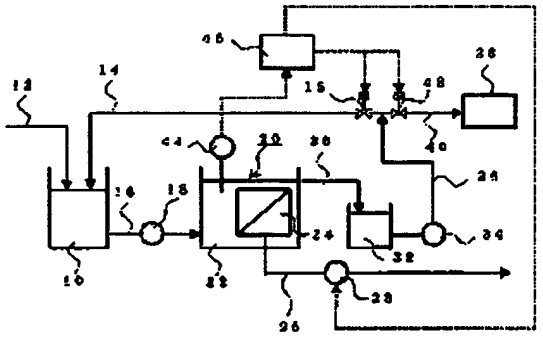
【図３】本発明に係る運転方法実行した場合に濃縮汚泥などの汚泥濃度の経時変化を例示した説明図。

【図４】本発明に係る運転方法の他の実施形態を示すフローチャート。

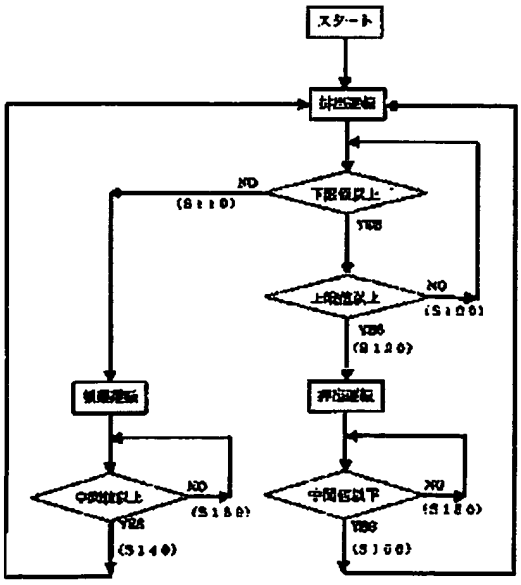
【符号の説明】

１０……汚泥供給槽
１５……切替弁
１８……（供給汚泥の）供給ポンプ
２０……膜分離装置
２２……分離槽
２４……膜モジュール
２８……（透過液の）吸引ポンプ
３２……汚泥溜
３４……（濃縮汚泥の）排出ポンプ
３８……汚泥貯槽
４２……切替弁
４２……汚泥濃度計
４６……制御

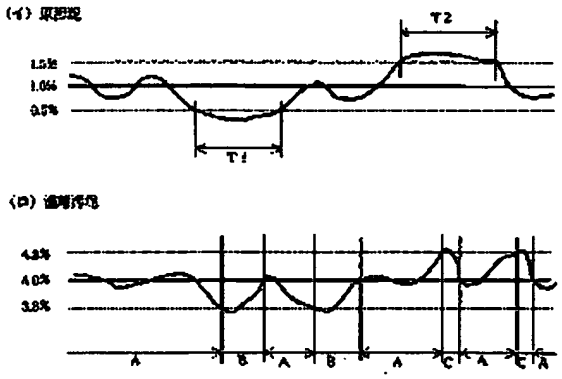
【図１】



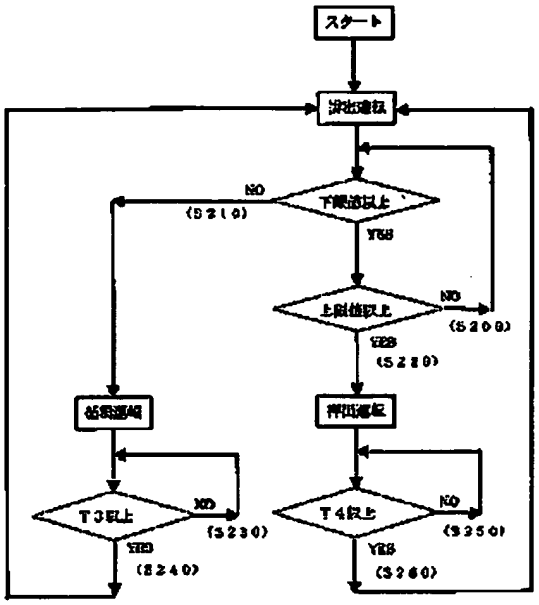
【図２】



【図３】



【図４】



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Ｆターム(参考)　4D006 GA06 GA07 HA01 HA21 HA41
　　HA93 KA63 KE11Q KE21Q
　　PA02 PB20
　　4D059 AA00 BE14